Seminar

Institute for Plasma Research

Title : Nano ripple patterning and band gap tailoring of muscovite mica sheet using plasma based ultra-low and low energy ion sputtering

Speaker: Dr. Dipak Bhowmik
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Date : 3rd March (Friday)

Time : 3.30 PM

Join the Talk: Online

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Abstract:
My research work comprises low energy ion beam-based surface and interface modification of materials. The low energy ion beam has unique property that it can modify the surface and near surface(interface) at nanometer length scale with very precise control. The well-defined pattern formation like ripple at nano scale level can be achieved by low energy (few eV to 10's of keV) ion beam sputtering. The band gap narrowing of material like insulating mica is very important for its application in optoelectronics devices and photocatalytic reaction.

In this talk, the ripple patterning on freshly cleaved flat mica sheet will be discussed first. The muscovite mica is a layered material (thickness of each layer~ 1 nm) having K atoms on the top surface interconnected with aluminosilicate layer. The ion bombardment can sputter the constituent elements in mica preferentially, which generates surface instability for ripple formation. The dynamics of the ripple has been studied in terms of scaling exponents. The projectile mass of the ions is also varied to study the mass dependent patterning on the surface and it is observed that mass of the ion plays a decisive role for ripple patterning on mica surface. The ion beam induced interface modification of mica surface is also explored. Almost, all the K atoms from upper surface are sputtered away during ion bombardment and aluminosilicate layer is also modified drastically by breaking Al-O, Si-O bonds. The physical as well as chemical modification alters the wettability properties of muscovite mica, which will be briefly discussed.

In the second part, the bandgap narrowing of muscovite mica by ion bombardment will be focused. Several ions with different mass (Ar^+, O_2^+, NO^+, N_2^+, and C^+) are used to irradiate the mica surface for band gap tailoring study. The mica is an insulating material having band gap ~ 4 eV; ion sputtering modifies its several layer and it changes the density of states of K, Al, Si, O in mica surface leading to band gap narrowing. The indirect band gap is reduced from 3.5 eV to 1.8 eV and the projectile mass plays an important role for bandgap narrowing. The monolayer modification by ultra-low energy plasma ion interaction shows the significant band gap narrowing to 1.2 eV, which could be useful for microelectronics and optoelectronics purposes. The band gap narrowing is supported from theoretical Density Functional Theory (DFT) calculation and experimentally via Conducting Atomic Force Microscopy study.